

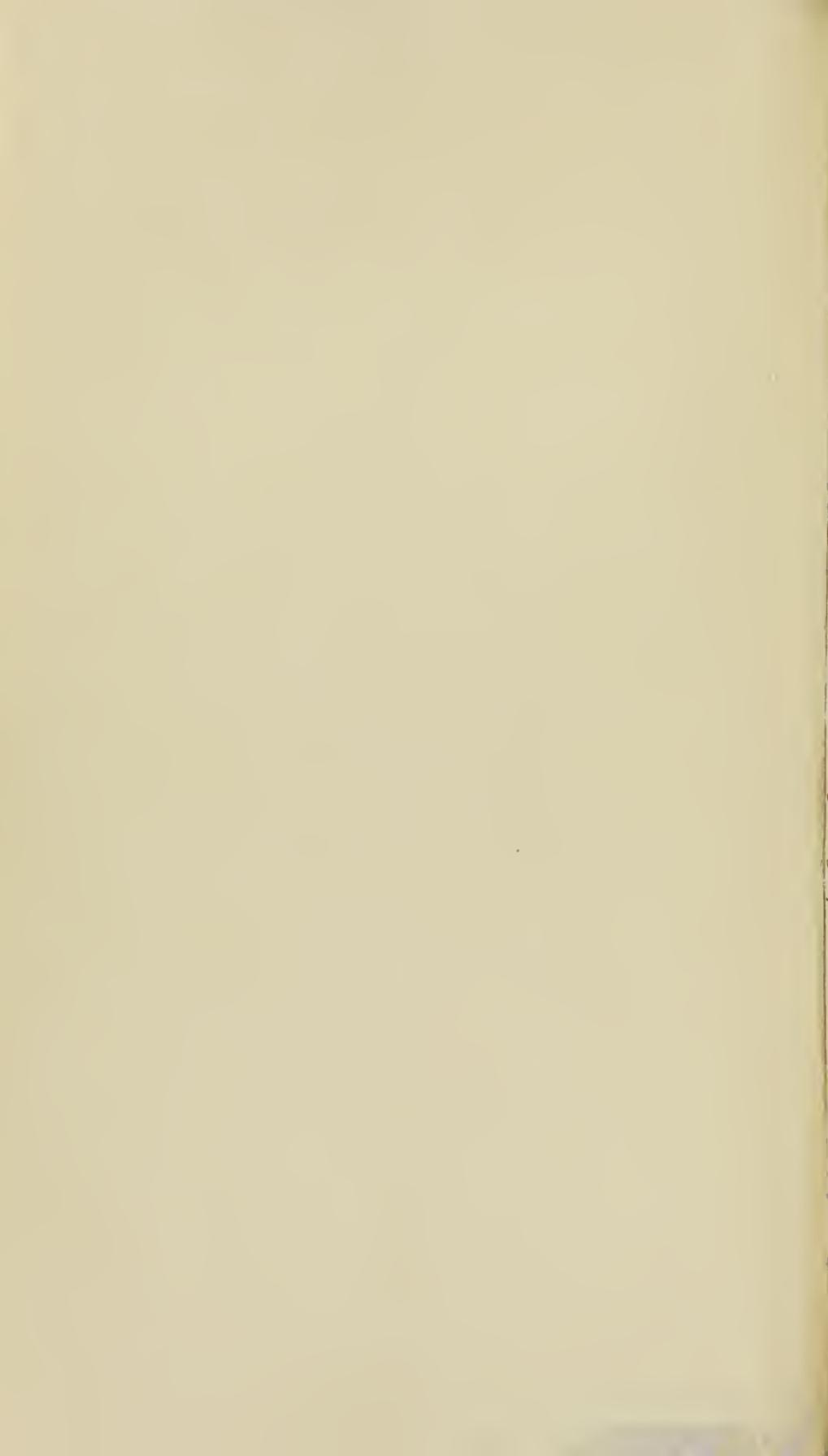
UNITED STATES OF AMERICA



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A N
INAUGURAL DISSSERTATION
ON *Sweat*
P E R S P I R A T I O N;
SUBMITTED TO THE EXAMINATION
OF THE
REV. JOHN EWING, S. T. P. PROVOST,
THE
TRUSTEES AND MEDICAL FACULTY,
OF THE
University of Pennsylvania,
For the Degree of
DOCTOR OF MEDICINE,
ON THE
Thirty-first Day of MAY, 1800.

By JAMES AGNEW, A. M.
Of Princeton, New-Jersey;
Member of the Philadelphia Medical Society.

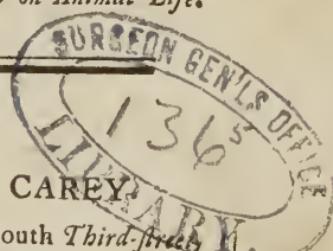
“ Simple Anatomy is a mass of dead matter—It is Physiology which infuses life into it.”

Rush on Animal Life.

Philadelphia:
PRINTED FOR MATHEW CAREY.

From the Press of D. HOGAN, N^o. 51, South Third-street,
opposite the United States Bank.

1800.





T O

JOHN MACLEAN, M. D.

Professor of Mathematics and Natural Philosophy,

IN THE

COLLEGE OF NEW-JERSEY.

SIR,

YOU will not, I hope, consider this dedication as a matter merely of form, or an attempt to annex your patronage to a performance which may little deserve it. My intentions, I flatter myself, proceed from a more disinterested motive.—Gratitude requires, that I should thus publicly acknowledge the many instructions I have received from you, as well in the character of a friend, as that of my constant preceptor.

These, Sir, I shall ever gratefully remember, and consider it as a duty I owe you, in future life to appear to have deserved them. With the highest respect for your talents, and sincerest wishes for your happiness,

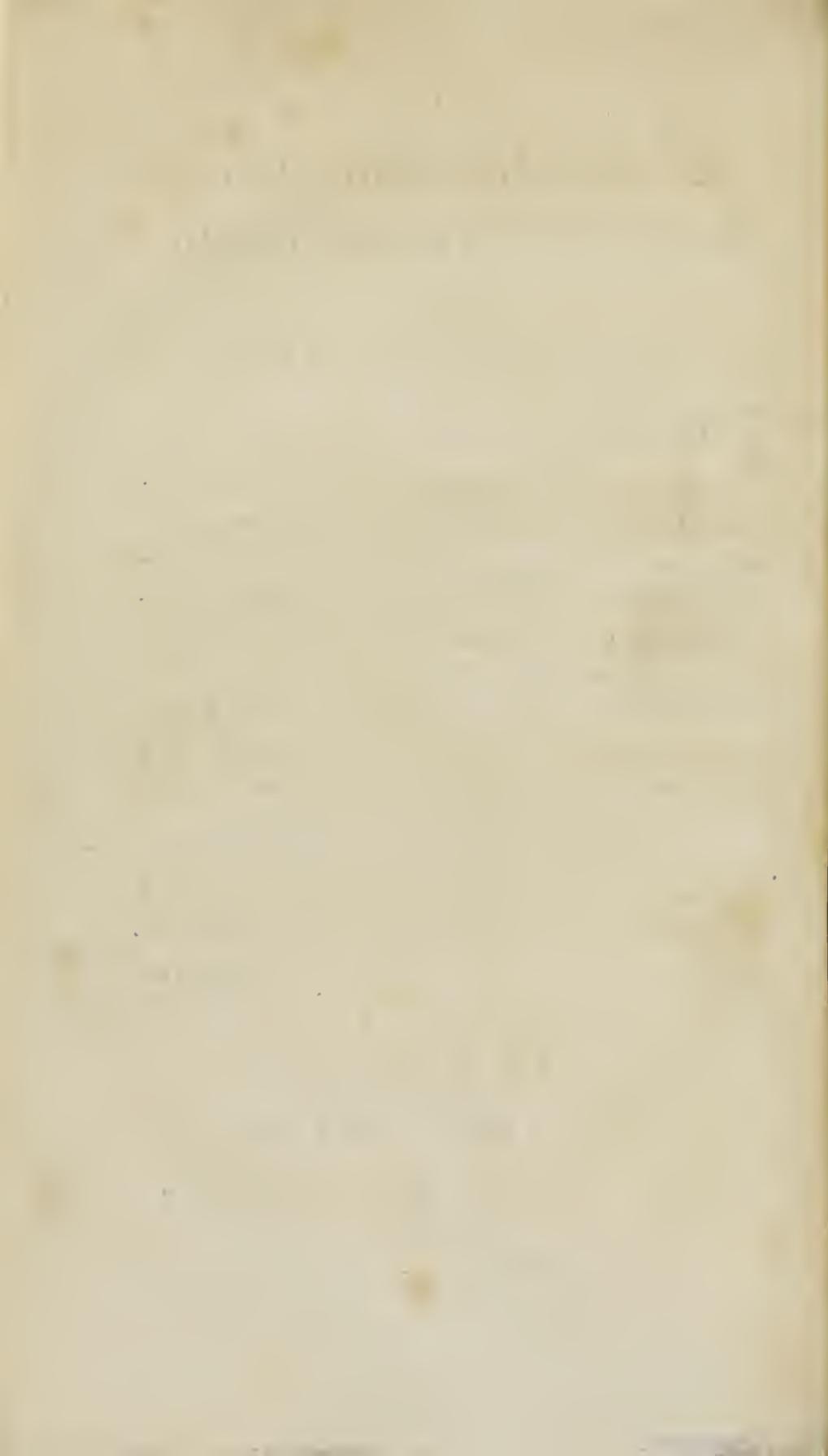
I have the honour to be

your Pupil and Friend,

JAMES AGNEW.

May 30th, 1800.

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O N

P E R S P I R A T I O N.

OUR skins are frequently covered with a fluid, called sweat. It has also been determined, by experiments which have been long known, that a fluid of a watery nature, but in a form commonly invisible, is constantly escaping from our surface; and by others of a more recent date, it appears, that substances which, when uncombined, retain, at all known temperatures, an ærial form, are at the same time emitted.

These are said to be perspired, the first by sensible, and the two last by insensible perspiration.

They have been the subject of much discussion among physicians. Some have considered them as proceeding from a common source; while others have supposed them produced by different means. Many have esteemed their

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emission as eminently essential to health, while a few, particularly of late, have regarded their retention as harmless, or at least of little consequence.

In this dissertation it is proposed, to inquire into the foundation and support of these different opinions, and, if possible, to decide between them. That this may be done, it is first of all necessary to be acquainted with the structure of those parts of the body from which they are emitted.

I. Of the external integuments.

These are the cuticle, rete mucosum, and cutis vera, to which may be added, the adipose or cellular membrane.

1st. Of the cuticle. It is a thin, transparent and insensible pellicle, closely joined to and connected with the skin. Its substance does not appear to be of a fibrous or vascular texture; but is uniformly continued and hard, in some measure analogous to the substance of which the nails are composed. On its inner surface it appears smooth and uniform, but on its outer it is covered with a great number of laminæ, connected in such a manner as to give it a squamous appearance. Its density differs in different parts
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of the body. On the inner surface of the hands, the soles of the feet, and such parts as are exposed to the attrition of other bodies, it is thick and hard; while on other parts, such as the cheeks and lips, it is exceedingly fine and tender. It adheres strongly to the skin, but after it has been macerated for some time, or slightly putrified, they may be easily separated. During their separation, a number of white filamentary processes may be seen passing between them; but which adhere to the cuticle when the separation is completed. These substances are tubular, and correspond to small pores or openings, which are distinctly visible on the external surface of the cuticle, even by the naked eye, but more particularly by the assistance of a microscope.—Different opinions have been entertained of its origin: Some have supposed it is produced by the matter exhaled, gradually hardening. Some, that it is the expansion of the excretory vessels, which are every where spread on the surface of the skin; and some, that it is by that of the nervous papillæ. But little is yet known of its true origin: one thing, however, is certain, that when abraded and destroyed, it is constantly and quickly re-produced.

2d. Immediately under, and adhering to the cuticle, is the rete mucosum; which is a substance in general of a greyish colour, and reticular or net-like form. It is composed of the extreme branches of the capillary vessels, which, after perforating the skin, are united and interwoven, forming meshes like those of a net, from whence it appears to have derived part of its name. When macerated in water, or suffered to putrify, it becomes of a soft, mucillaginous nature, seeming to be nothing more than inorganized matter, or mucus; and hence, probably, the term *mucosum*. In the inhabitants of the torrid zone it is black, or of a darkish colour; but in Europeans it is more or less inclined to white. It is considered as the cause of the colour of the skin.

~~This~~ is not generally agreed from whence this substance is derived; some supposing it to be formed of a humour exuding from the true skin. But that it consists of vessels continued from the vascular system, seems probable from the fact of blushing; for the colour beneath the cuticle at this time, is too general and diffused, to be attributed to vessels less minute and extensive than those forming the rete mucosum. Were not this vascular, but impermeable to the blood, by intervening between the cuticle and the vessels which convey the blood, it

it would, from its colour, prevent the red from being seen. The vascularity of the rete mucosum, has been demonstrated lately by the injections of Mr. Baynham of London. In inflammation also, a reticular texture of vessels is to be observed on the surface of the skin. And although neither of these facts prove "these vessels, in a natural state, to contain blood;" yet the force of circulation at some times may be so great, as to force into serous vessels a quantity of red globules, and thus by affecting the vessels under consideration, occasion that redness which we observe in blushing and in inflammation.

3. The cutis is the most interior of what are properly termed the external integuments. It is contained immediately within the cuticle and rete mucosum, and is separated from the muscles by the fat and cellular membrane. It is strong and flexible, easily admitting of extension in the various flexions of the body and limbs. It seems to be composed of numerous fibres, running in different directions. This texture is particularly observable in leather, and seems to form the body of the skin. It is covered on its exterior surface by little eminences, which appear like small granulations, and are termed papillæ. These are considered as being made up of the terminations of nervous filaments,

ments, together with those of small arteries and lymphatic vessels. They have been described as of different figures in different parts. Those on the soles of the feet, and in the hands, are most observable, being higher and more closely united ; they appear to be disposed in rows, forming lines either of a strait, curved or irregular form, as on the ends of the fingers and toes. The skin is plentifully supplied by arteries and veins, which every where perforate and ramify through its substance, as has been fully demonstrated by anatomists, by many fine injections. The arteries terminate here in very minute vessels, which have been called the cutaneous capillaries. These, after numerous ramifications, unite with their corresponding veins at angles, more or less acute, from which proceed vessels called exhalants, as is proved by injections. And this appears to have been the opinion of Haller, when he observes, that the cutaneous discharge is secreted,
 " ex arteriis exhalantibus, quæ nullo medio
 " folliculo ex rubris arteriis nascuntur. In va-
 " sis perspirationem cutaneam fundentibus in-
 " jectio aqua vel glutinosa tenuior ex ar-
 " teriis ita exfudat, ut nullum dubium super-
 " sit."* They terminate on the skin by open
 mouths,

* Prim. lin. Par. 196.

mouths, which receive into them the little tubes, projecting, as already mentioned, from the inside of the cuticle.

Besides the open terminations of these vessels, and the pores of the cuticle, there are other openings in the integuments, viz. the mouths of the absorbent vessels, which, although invisible, yet must certainly exist; as the absorbents may easily be traced as far as the skin; and certain substances, when rubbed on the surface of the body, will be absorbed and carried into the circulation. As connected with the skin, may be mentioned the hairs. These are found in almost every part of the body. They seem to originate from a bulb, or root, situated between the skin and adipose membrane, and to perforate the substance of the skin.

In many places we find small reservoirs of sebaceous matter, as about the nose, ears, axillæ, &c. This is supposed to be secreted by glands situated in those places, termed the sebaceous glands. The existence of such glands, if not demonstrated, is admitted in anatomical writings.*

II. The

* New. Syst. Anat. Vol. I. pag. 463.

II. The next inquiry proposed to be made, is into the sensible and chemical qualities of the perspired fluids.

And, 1st. Of the sweat. It is of a watery form. is greasy to the feel, and saltish to the taste ; it often has a peculiar smell, which, however, is different in health from what it is in disease. Besides water, the sweat contains other substances ; a quantity of salt, which gives it the taste, and an unctuous matter which remains on the skin, or is imbibed by the clothes, and which, unless it be wiped off, becomes filthy and unpleasant. It is probable that the difficulty with which this substance can be washed off, has led to the invention of soap. The celebrated Dr. Mitchell of New-York, has supposed, " that alkaline and saponaceous mixtures " remove all greasy substances, by virtue of " the stronger attraction they exert towards " them, than these for the cuticle or the gar- " ment worn next to it."* For my part, when I consider that the adhesion of the greasy matter to the cuticle, is not owing to any chemical union between them, and that alkalies form with oil a substance which is miscible in water, I am inclined to attribute their effect in cleaning the skin, merely to their unit-
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* Med. Repos. Vol. III. N°. 2. pag. 165.

ing with the fatty matter of the sweat, to form a substance that may easily be washed off. The sweat also frequently contains an acid. * Dr. Dobson observed this in a diabetic patient; and supposed its appearance to be owing to a secretion of part of the chyle by the skin, and undergoing an acetous fermentation. This hypothesis, however, admits of no proof. That chyle should be received into the mass of blood, and pass through the circulation, without suffering a change, physiologists are disposed to deny. Mr. Berthollet affirms, that he found sweat to redden blue paper, and concludes the acid thus discovered to be the phosphoric.†

When the perspired matter does contain acids, alkalies will neutralize them, and thus the effect of alkaline mixtures in cleaning clothes impregnated with sweat, may be two-fold, the rendering the grease miscible with water, and the neutralizing the acid. Dr. Mitchell is of opinion, that sweat, or, at least, that clothes which have been impregnated with it, contain occasionally some nitric acid. This may be possible, but the proof which he adduces of it is not satisfactory. He says, that the sailors in West India voyages, for want of soap, frequently wash

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* Med. Obser. & Enq. Vol. V.

[†] *Fourc. Elements*, pag. 207.

their clothes with molasses, as a substitute for it ; and he is of opinion that this acts by decomposing the acid. But the molasses may serve to clean clothes, just as fullers' earth, meal, or bran, serve to clean wool, viz. by forming with the grease a substance which is miscible with water.

Sweat is united in some parts of the body with the secreted matter of some glands ; from this deriving peculiar qualities and appearance. Hence we find it more fetid in the groins, arm-pits, &c. where these glands are most numerous. After eating particular substances, or taking some medicines, their smell, as well as taste, are sometimes to be discovered on the skin. Even blood has been observed in the sweat.

2d. Of the insensibly perspired watery fluid.

The discovery of this discharge, though generally attributed to Sanctorius, who, from his experiments on it, established many aphorisms respecting the preservation of health, is as ancient as Galen. That it was known to him, is evident from his own words : * “ This excrementitious vapour,” says he, “ is expelled through small orifices, which the Greeks call pores, dispersed all over the body, and especially over the skin,

* De Sanit. tuend. lib. iii. cap. xii. sub finem.

" skin, partly by sweat, and partly by insensible perspiration, (adelos ais thesi diapnoe) which escapes the sight, and is known to few."

This emission may be made evident by the following experiment: If a looking-glass be held near to a healthy body, it will, in a short time, become covered with moisture in the form of a cloud or mist, which, uniting, will at length stand in drops on its surface.

It may also be detected by including part of the naked body in a glass vessel, secluded from the air; in a short time its inside will become covered with drops, and at length a sufficient quantity of moisture may be obtained to be submitted to examination. * Mr. Abernethy found it to be insipid, and not perfectly transparent. On evaporating half the fluid which he had received, a slight crust was left on the glass, which was not salt, but had a burned smell. Caustic alkali, when added, had no effect on it. It however converted to a faint green the vegetable blue colour. Marine acid had no other effect on it, than precipitating a small quantity of mucous-like matter. He also remarks, that in some observations he made on the water exhaled from the lungs, he discovered no salt, but

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* Functions of the Skin, pag. 141.

he found mixed with it, a similar mucous matter, which gave it some viscosity. Mr. Cruikshank, and others, have also investigated this subject; but little else has been said, that can be depended on. But if confidence may be had in the experiments mentioned, the qualities, at least of the insensibly perspired watery fluid, may be considered as in some measure known.

3d. Of the æriform or gaseous fluid. The subject of this gas has occupied the attention of several writers, who have made nearly similar conclusions.

Dr. Priestley, in attempting to investigate the change produced in the atmosphere, by animal perspiration, declares it different from that produced by respiration. He therefore asserts, that that process does not injure the purity of the air in the same manner with the latter. In this he is contradicted by the experiments of those who have come after him.

Dr. Ingenhouz observed air to be perspired from both animals and vegetables; but did not attend much to its analysis. He observes, however, that “ it seemed partly fixed air, as it “ was somewhat absorbed by water.” And the remainder he considered as unfit for respiration.

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This matter was also slightly examined by Mr. Cruikshank. He added lime water to the air which was the subject of examination, when, from the precipitation of the lime, he concluded the presence of fixed air, and also remarked, that a candle burned dimly in it.

The qualities of the gaseous fluid have been more directly attended to by Mr. Abernethy. In a course of experiments made by him, much time and pains appear to have been taken to accomplish this end. * By receiving these gasses over mercury, he was enabled sufficiently to examine them; and he observes, that on throwing up lime water, "two-thirds of the received air was rapidly absorbed; and on the addition of nitrous gas to the remainder, neither red fumes, nor any diminution in the quantity of air took place." This experiment, he says, was repeated six times, with similar results. He therefore concludes the air perspired, to consist of carbonic acid and azotic gasses. In one experiment, he made this last to be to the whole as one-fourth; and in another, more than a third. But in general he is of the opinion, that the proportion of these gasses, is two-thirds of carbonic acid gas to one of azote.

These

* Experiment A. pag. 111.

These experiments, although they cannot be considered decisive as to the quantity of the gaseous fluids, go a considerable way towards a discovery of their peculiar properties. Some objections, however, may be offered to the manner in which the experiments were made, as tending to create uncertainty in their results. For in those where mercury is the medium, he could not attribute the air collected entirely to the source of perspiration; as mercury is found to contain air, by immersing in it any substance of a filamentous texture, the hairs, for instance, which cover the hand, from their capillary power, though particles of air will be attracted, and uniting into larger, will rise to the surface, and thus may serve to characterize the gas which is to be analyzed. A similar observation may be made with regard to those made in water.

The collection of air from water is known to every one. It may be freed of its air by boiling; and by this means its power of absorption is increased. In the experiments marked B.* Mr. Abernethy observes, that on introducing his hand into the water, particles of air appeared on it, which by agitation were detached, and ascended. But retaining his hand there for some

* Pag. 114,—117.

some time, no more air was produced.. On repeating the experiment frequently, and changing the water, much greater quantities of air were obtained. When warm water was used, little or no air was produced. The water then, in this case, appears to be one source from which it is derived ; and although the air collected, in every instance, cannot be ascribed to this cause, nor its properties produced by the media made use of, yet its influence, in altering the proportions, and possibly the qualities of the contained air, must be considerable.

III. The third general enquiry, which is now to be made, is the quantity of the fluids emitted : 1st, The quantity of sweat is different at different seasons ; warm weather increasing, while cold lessens its discharge. There is naturally not so much, therefore, in winter as in summer : but though it does not stand upon the skin, there is always enough to impart to it a disagreeable taste and smell. This is a circumstance well known to those who wear flannel next their skin. For unless cleanliness be much attended to, the shirt, after becoming saturated with the sweat, will be found frequently covered with a layer of grease : the same may be often observed on the cuticle. When the temperature of the air approaches nearly to that of the human body, the quantity

of sweat becomes more considerable. This is particularly to be observed after much exercise is used ; it then stands in drops on the skin ; and labourers, reapers, &c. who are exposed commonly to the combined influence of these powers, frequently perspire so much as to be able to wring out large quantities from their shirts.

In many diseases also, the quantity is very considerable. There are many instances on record, as well as some which have come within our own observation, of sweats so large as to cause astonishment. * Dr. Willis mentions the case of a lady, whose sweats were so prodigious, that basins were placed between her thighs to receive the humour which trickled down them. † Hoffman also, speaks of an old man subject to continual sweats, which proceeded to such a degree, “ that his whole nourishment “ passed off by his pores.” Similar instances might be cited from many more of the old writers. But cases of sweats, equally surprising, have been noticed by writers of a later date. ‡ Darwin relates several of this kind ; one in a gentleman affected with a dyspnoea and swelling of the legs, when “ so copious a sweat came out

“ from

* De Diaph. nimia. & depravata, sect. 5. cap. iii.

† Turner de Morb. cutan. pag. 84.

‡ Zoonom. Part I. pag. 360.

" from his head and neck, that in a few hours
 " some pints, by estimation, were wiped off
 " from these parts." Two others he men-
 tions, of sweats so profuse as to " deluge the
 " bed" on which they lay.

Fevers mostly terminate in sweats ; and these are generally more or less profuse, according to the violence of the force of circulation in the preceding paroxysm. These are subjects of common observation, but in some instances they go to greater excess than in others. Every one who has been in any measure acquainted with the autumnal intermittents of this climate, must have particularly remarked this. Solitary instances may also have been observed, by many persons, of sweats not less copious than have been related. Such a case I witnessed last autumn, in a man affected with the epidemic of that season. In him the sweat was so prodigious, as to stand in his hair, and on his temples, in the form of a foam, and the blankets which covered part of his body, exhibited the same frothy appearance. On his neck and breast, which were exposed, it was condensed, not in drops, but ran in streams down his sides, completely wetting the bed below him ; and (to mention a circumstance which should have been noticed when treating of the qualities of sweat) the bile (probably, was perspired in such

quantity as to colour that part of the bed on which he lay, with a deep yellow.

On the exhibition of certain remedies too, the emission is often exceedingly profuse. And the uniform effect of some articles, in promoting this end, still retains to them the title of sudorifics.

2d. To ascertain the quantity of the insensible perspiration, numerous attempts have been made, by many curious investigators.

Sanctorius was the first who proposed the discovery of this discharge, by calculations drawn from a reference to the balance. By weighing the aliment taken in a given time, and by the same method ascertaining the weight lost by the body in the same time ; he determined the loss through this channel to be equal to five eighths of the food taken in, or all the other excretions taken together.

As the difference of climate, however, occasions considerable variety in the quantity of perspiration, the results from experiments, in different countries, must vary ; convinced of this fact, several physicians have pursued a course of statical experiments, in order to discover the proportion of the sensible and insensible evacuations in the country in which they lived. For this

this purpose were made the observations of Dodart, Keil, De Gorter, Rogers, Linen, Bryan, Robinson and Abernethy. None of them, however, appear sufficiently accurate. Sanctorius makes the insensible discharge too great. He supposes all the vapour emitted from the lungs to be perspired, whereas some of it probably may be formed by the union of the oxygen of the atmospheric air with the hydrogen of the blood in the lungs. Part of the loss sustained, is to be attributed to the waste of the matter, which, together with the oxygen of the atmosphere, forms the carbonic acid gas emitted by the lungs. As those who treated this subject after him, made their experiments in the same way, their results appear equally inaccurate.

Abernethy makes it too little: the manner in which his experiments were made, renders the sum perspired, liable to great uncertainty. * He used "a glass jar covered with a wetted bladder, in which an aperture was left, through which he introduced his arm, around which the bladder was tied; so that the ascent of any vapour was prevented. In six hours he procured nearly three drams of limpid tasteless water." He calculated the discharge which should take place, from the whole

* Experiment. pag. 134.

whole body, supposing it equal in all parts, by comparing the surface exposed in the experiment, with that of the whole. This was done, by covering his hands with slips of paper, and measuring their extent. The result, by this method, must be too small; for he could not, in this way, find the true surface of the hand, as the fingers are not perfectly cylindrical, but irregular, containing cavities and angles, from whence the perspiration is more perceptible than from other parts. The result, therefore, being less in this part, the sum or total discharge will be proportionably so. The total discharge, according to his calculations, was only two pounds and a half in a day, the temperature of the air being at 65° . But it would amount to considerably more, for in Mr. Abernethy's experiments, we must remember, that he supposes the perspiration not only equal over the body but through the day; and as his exercise and temperature was at that time less than if he had been making the ordinary exertions of a man in health, he made no allowance for the greater quantities perspired from these causes. The experiment on which the above calculation depends, is liable to an objection—the air included in the vessel would soon become saturated with moisture, and thus there would be presented to the mouths of the absorbent vessels of the skin, a quantity of a watery fluid, which they would readily

readily absorb; whereas, in the ordinary situations of the body, the moisture is either sucked up by the clothes, or dissolved and carried away by the air. Thus, the quantity emitted from the skin must be considerably more than he supposes. It will be difficult, however, from these circumstances, to ascertain it exactly.

3d. Many results have been given by Mr. Abernethy, of the quantity of the æriform perspiration, but the greatest appears to have been about an * half ounce measure in sixteen hours, from the surface of the hand and wrist, computed at seventy square inches, which is, at that rate, not an ounce in a day, or twenty-four hours. This may be less than the sum discharged, as, according to another set of experiments, a great absorption was found to take place. It was found, by exposing the hand to different proportions of air, insulated in a glass vessel, that this air, instead of receiving an increase, was constantly diminished; the qualities of the remainder, however, being in some measure changed by part of that which was absorbed being supplied by a portion discharged. The air absorbed, was observed to be more or less, according to the purity of the air contained.

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* Experiment A. pag. 113.

IV. The origin of these fluids is the next inquiry I shall make on this subject. Sweat, and the insensibly perspired fluid, according to the opinions of the old writers, were not only different in their properties, but differently produced. The latter, they believed to be nothing more than a watery vapour, simply exhaled from the serum or finer parts of the blood, as no longer necessary to the health or growth of the animal. This they supposed was effected by vessels continued directly from the arteries to the skin, and therefore as constantly in action, as the arteries themselves, or the heart from which they are derived. This kind of perspiration they thought was not of temporary duration, but constantly taking place, unless prevented by disease. Hence the great attention of the followers of the humoral doctrine to the state of the skin, and the matters perspired. By the action or want of action, in these vessels, they pretended to explain the crisis, cure, or fatal termination of diseases.

But sweat they considered as consisting of a greater number of principles, and as being secreted from the blood for different purposes. The organs of this secretion were glands, which, from their situation beneath the external skin, were termed subcutaneous, but from their figure, miliary glands. From these substances

stances it was conveyed by excretory ducts, which, perforating the rete mucosum, discharged it through minute pores in the cuticle. To each of these pores they imagined a scale or covering to be affixed, which, from, its shape and situation, was to act as a valve, to retain or permit the passage of the fluid at pleasure. Many descriptions have been given of the figure of these scales; but Liewenhoeck, by the assistance of his glasses, claims greater accuracy than any who have written on this fanciful subject. He observed them to consist of "five sides, and lying over each other like scales on a fish, * giving an uniform appearance to the skin and the † white colour which exists in most parts of the body." Around these scales were arranged the pores by which the insensible discharge was emitted. This variety in the vessels which were subservient to perspiration, according to Boerhaave,‡ was admitted by the ablest physiologists of those times. With respect to the use of glands, however, in the production of sweat their necessity was by some denied. Ruysh would not admit their existence, and in opposition contended for that of mere follicles for the purpose. Malpighi maintains the former opinion, and pretends to have demonstrated the glands.

But

* Arcan. Nat. tom. i. part ii. pag. 47. † Ibid. pag. 51.

‡ Boerhaave's Lectures.

But notwithstanding they differ on this point, they both suppose a difference in the nature of the cutaneous evacuations. From the description they have given of the vessels concerned in insensible perspiration, they seem necessarily to suppose it directly emitted from the blood ; yet the admission of glands and excretory ducts in the production of the other, would induce us to believe they considered it a secretion. But the truth of either of these theories can only be established by the discovery of such glands, or follicles, as have been supposed by their proposers. On this head, however, we have little satisfactory evidence, for notwithstanding all that may have been said by Ruysh and Malpighi,* “ it is certain that no distinct glands or “ follicles can be traced by the knife.”

That the matter of perspiration is discharged by different vessels, is further rendered improbable, by no vessels having been discovered, by injections or otherwise, which originate from the sanguiferous system, except those which have already been described when treating of the skin.

Both must be considered as originating from the blood ; for as this is the source from which every

* New Syst: Anat. pag. 436.

every solid, as well as every fluid which composeth the animal body, is derived, to it must these and every secretion be attributed. In it are contained all the principles of which the perspirable matter has been discovered to consist:

" * Qui cogitavit in sanguine reperiri serum co-agulabile," says Haller, " aquam exhalantem, mucidum aliquod viscidum, oleum denique, incipiet percipere, potuisse omnino fieri, ut hujusmodi liquores, ex sanguine separarentur " ut qui principia sua in massa sanguinea habent." In order then to understand the production of the perspirable fluids, it is necessary to take into consideration the circulation of the blood, and its consequent distribution into the different vessels capacitated to receive it. The heart being endued with the principle of irritability, contracts when irritated by the blood, and forces it into the arteries; and these being possessed of the power of contractility, derived partly from their elasticity, and partly from their muscularity, react on the blood, which, meeting with the least resistance, must pass towards their extremities. By these means, the blood is continued in its progress, till its return by the veins. But it must have answered its particular purpose in the circulation before its return to the heart. Every part

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must

* Prim. lin. par. 193.

must be supplied with its proper nourishment, every gland with the matter fit to form its secretion, every surface lubricated with its proper fluid, and the unnecessary and feculent portions separated. If the exhalants are directly continued from the arteries, they must participate in their action, and must receive such parts of the blood, as can be forced into them by their contraction. The diameters of these vessels being too small to admit the red blood, if the action of the heart and arteries be moderate, the fluid propelled into them will be the thinner part of the blood, as the aqueous, and a portion of the saline parts of the *serum*, together with such particles as are capable of receiving an ærial form, and may be necessary to be eliminated from the system.

Part of the fluid which is thus emitted, will be sucked up by the absorbent vessels, which arise from the surface, part of it will be imbibed by the clothes, where they are applied to the body; part of it will be dissolved by the air, from such parts as it comes in contact with; part of it will be dissolved in the gasses that are emitted; and if the quantity discharged should be greater than what the absorbents can suck up, and the æriform fluids dissolve, then will an accumulation of it take place in such parts as are not touched by the clothes, or to which the
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air has no access, as frequently happens, between the toes and other recesses of the body. But when the force of circulation is greater, more fluids will be forced into the exhalants, and thus the quantity of perspired matter will be increased. If it be more than the causes already assigned for its removal can dissipate, it will remain in a visible form on the skin. Thus, then, the insensibly perspired watery fluid, is that which is dissolved by the air and the gasses emitted from the skin; while the sweat is the saline, oily or mucous parts which remain, unabsorbed, or is imbibed by the clothes.

On this principle, we can account for the appearance of sweat from the operation of internal stimuli, or from exercise. For by increasing the rapidity of circulation, the successive portions of fluid are more frequently brought to the surface, and discharged.

In the same manner we can explain the profuse sweats, which succeed the hot fit of fevers, particularly those of the intermittent type. In the cold stage, the blood leaves the cutaneous vessels, retiring towards the inner parts of the body, as appears by the paleness and shrinking of the muscles of the face, the shriveling of the skin, and the drying up of ulcers.* It therefore, collects

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* Cullen's First Lines.

in unusual quantity about the heart and the vessels in its neighbourhood. The heart being thus preternaturally distended, contracts with greater force, and propels the blood again towards the surface of the body ; but the vessels of that part having, by the previous recession of the blood, lost an accustomed stimulus, become more irritable, so that when the blood is again driven towards them, their sides are excited to contract, become more dense, and their diameters are lessened ; nay, perhaps, they may be rendered quite impervious ; and thus they afford one obstacle to the passage of the blood into them. But the force of the heart and arteries being greater than this resistance, they, through repeated exertions, dilate the cutaneous vessels, a certain ring or portion of the artery being distended by each succeeding impulse, until at length they are filled with more than their usual quantity, and pour out a preternatural quantity of sweat. And this will continue until the violent action of the heart and arteries becomes lessened, from the stimulus which caused it ceasing equally to excite it. Hence, the quantity of fluid discharged will gradually become less, and will at last disappear. As the sweat continues to flow, the heat of the body, from the constant evaporation which takes place, will be gradually diminished, and will at last return to its usual temperature.

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I am aware, that other explanations have been offered for the appearance of sweat in fevers. But this appears to me the most satisfactory.

* Dr. Darwin asserts, that the perspirable matter is secreted in as great quantity, during the hot fit as afterwards, when the sweat is observed on the skin; but that during this stage, the cutaneous absorbents acting with greater energy, and the exhalation being augmented by the increased temperature of the skin, the fluid does not remain on the surface, but is in part re-absorbed, and in part dissipated in the air. And he ascribes the after appearance of sweat, to the action of the absorbent vessels being lessened by the application of cool air, or cold bed clothes.

The doctor, however, has taken for granted what has not any where been demonstrated. † “The heat in fevers,” says he, “ arises from the increase of some secretion.” Hence the increase of perspiration, which by him is considered a secretion, produces an increase of heat; for increased secretion “ is always attended with an increase of local, or general heat.” But as the temperature of the secretions has never, by any experiment, been ascertained, this assertion cannot be admitted.

* Zoonom. part ii. pag. 20.

† Ibid. pag. 19.

mitted. Chemical changes are, to be sure, always attended with a change of temperature; but it does not follow, that it must be an increase of temperature; for they are certainly sometimes followed by a diminution of temperature. The principle, then, that the heat of the skin in fever depends on increased perspiration, is without foundation. On the contrary, the heat must be diminished by perspiration, for a great part will, as he has supposed, be carried off by the air; and the solution of any fluid in air is attended with a diminution of temperature. Nor can the non-appearance of sweat in the hot stage, be attributed to the greater absorption from the skin; for although it be admitted, that the action of the absorbents is increased in proportion to that of the secerning system, yet the absorption will be prevented, as may be shewn from his own principles. For “when the sanguiferous system is “full of blood, the absorbents cannot act so “powerfully, as the progress of their contents “will be opposed by the previous fulness of “the blood vessels.” If sweat, therefore, were to take place during the hot fit, while the vessels of the skin are unusually distended, as appears from the great fulness and turgescence of every external part, as it could not be re-admitted through the absorbents, and part of it

it only being dissolved by the air, it would easily be observed.

The opinion, that sweat becomes visible in consequence of the diminution of temperature, which before prevented it, is further rendered improbable, by persons frequently passing from the hot to the sweating stage, without being exposed to cooler air, or a change of bed clothes. The fact derived from Mr. Alexander's experiments, viz, that sweat does not appear until the heat of the skin has fallen from 112° to 108° , does not here apply. For from his experiments it appears, that when the temperature is increased by the artificial application of external heat, beyond the boundary of health, sweating is prevented. In this case, from the power of the stimulus, the capillaries are excessively excited, and hence constricted, until, by the application of cold, an abstraction of heat takes place, and a consequent diminution of excitement, when the cutaneous vessels become again dilated, and the sweat begins to flow. But in fever, the temperature of the body never becomes so excessive, and the heat of the skin never surpasses so far that of the internal parts; and as the heat of the skin is derived from the constant influx of the blood into its vessels, its temperature cannot be lessened before the commencement of perspiration,

perspiration, as there is no other cause of alteration.

The explanation, therefore, before given, appears to me, the only proper or satisfactory one that can be offered, of the "warm sweats," or those which succeed fevers.

On the same principles are to be explained the profuse colliquative sweats, which take place in that exhausted state of the system, which precedes death, and is consequent on fevers of the continued form. In these the action of the sanguiferous system, together with the excessive operation of heat, contribute finally to exhaust the extreme vessels, which from the debility thus induced, are no longer capable of permanent contraction, but become expanded, and permit the fluids, which are still continuing to be sent to them, to be discharged on the skin. But as the action of the absorbents is, at the same time, diminished with the resistance of the capillaries, they will imbibe less than usual ; and thus the sweat will be accumulated on the surface.

As the heat of the body is diminished by the evaporation from its surface, and the accumulation of it prevented by the inaction of the vessels ; the sweat which stands on the surface, will

will convey to a person the sensation of cold. The viscosity of sweats in such cases, may be owing to the watery part being dissipated in the air, while the oily and coagulable parts remain unabsorbed ; perhaps also some other parts will be discharged, from the little resistance of the exhausted capillaries.

A different opinion respecting cold sweats, has been offered by Dr. Darwin, who calls to the aid of his theory, his favorite hypothesis, the retrograde action of the absorbents. But upon examination, it will be found, that his theory on this subject, as well as the principle on which it depends, are more ingenious than true. The lymphatics are universally known to anatomists, to be supplied, at very minute distances, with valves, which, from their situation, must be intended to prevent the regurgitation of their contents. This cannot, therefore, take place, unless the fluid be driven back with such violence as to force or tear the valves. But in order to get over this difficulty, he observes, that, * "as these valves are placed in vessels " which are endued with life, and are them- " selves endued with life also ; and are very " irritable into those natural motions, which " absorb or propel the fluids they contain, it

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* Zoonom. part i. sec. 29. 2,

" is possible, in some diseases, when these
 " valves or vessels are stimulated into unnatural
 " exertions, or are become paralytic, that du-
 " ring the diastole of the part of the vessel to
 " which the valve is attached, the valve may
 " not so completely close, as to prevent the
 " relapse of the lymph or chyle." And he adds,
 that this is rendered probable, by injections of
 mercury, water, &c. easily passing the valves,
 contrary to the natural direction of the fluids.
 That these vessels, as well as their valves, are
 endued with life, will not be doubted; but that
 they are possessed of that degree of action which
 he seems to ascribe to them, is, I believe, not
 allowed by all. Some have attributed their
 power of absorption to capillary attraction;
 but whether their functions as vessels are to be
 referred to this, or to a contractile power in-
 herent in them, has not yet been sufficiently as-
 certained. But admitting them to possess a na-
 tural capacity for action, it is scarcely probable
 that their action could become so excessive.
 And supposing the strength of the valves pro-
 portioned to that of the vessels, as they are
 known to be exceedingly tender, an extravasa-
 tion would seem as apt to take place as a regur-
 gitation. That this should be caused by a paraly-
 sis of the vessels, appears still more improbable;
 for as in this case, the vessels are unable to act, to
 suppose a return of the fluid from this source,
 would

would be admitting an effect without a cause. The doctor has also made use of several analogies with other vessels, to prove the point in question, but they do not seem strictly to apply. He has supposed it from the regurgitations of the contents of the stomach and lacrymal sack, and the recession of the blood in the capillary vessels. But the analogy here cannot be admitted ; for the stomach, although its orifices have generally been said to perform the offices of valves, cannot be considered as possessing them. Besides, the number, strength, and rigidity of its muscular fibres, together with the functions which it is intended to perform, render it very dissimilar. The lacrymal ducts and capillary vessels, have never been supposed to contain valves, and therefore will the more easily permit a retrograde motion of their fluids, when a cause affects them. He has mentioned but one fact, that would seem to strengthen, in any degree, his theory. He * " tied the neck and ureters of a " fresh ox's bladder, and made an opening at " the fundus of it ; then having turned it in- " side outwards, filled it half full with water, " and was surprised to see it empty itself so " hastily." But no proof, in my opinion, is de- rived from this experiment, for although the bladder was found to empty itself, it does not follow

* Zoonom. part i. sect. 29. 2.

follow it did so by the passage of the water through the lymphatics. The bladder is plentifully supplied with blood vessels, which also pass on to it, from its neck, and by their separation with the bladder from the body, will afford as speedy a passage as the one supposed.

If a lymphatic be compressed, by the action of muscles or the pressure of any body external, the contained fluid retiring from the force, will escape at that part where it meets the least resistance, and will consequently be forwarded towards its destination. The idea, then, of the regurgitation of the absorbed fluids, seems merely fanciful, and the explanation of any effusion from this cause entirely unfounded.

2d. The origin of the æriform substances perspired, cannot so easily be ascertained. The experiments on this subject have only discovered the quality of the air emitted ; its source remains yet for further investigation. We know, however, that the blood is constantly undergoing a change in the lungs, by a particular process which takes place there, probably similar to combustion. Carbonic gas, in this case, is emitted from the lungs, whether formed there or existing in the blood. The latter opinion is embraced by some, though the former is most generally adopted. I may venture, however, on an hypothesis, that,

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as the union of oxygen is believed, its combination with carbone in the blood may be the origin of the gas that is emitted from the skin. The existence of azot, in the blood, and most animal substances, has been demonstrated by numerous experiments; but in what manner, or by what process, its separation is produced, must be left for future facts to determine. Little, therefore, can at present be with certainty said, as to the origin of the aerial discharge.

V. Having now considered the qualities, as well as the quantity and production of the matters which constitute the perspirable discharge, as far as could be ascertained from the experiments and facts related by different writers, I shall next proceed to the consideration of the question, Whether the retention of the perspirable matter, is ever productive of derangement in the system?

Sweat, before the knowledge of the insensible discharge, was considered by the humoral pathologists, as an excrementitious fluid, necessarily separated from the system, and productive of disagreeable and dangerous consequences, if retained in it. That this, even in the infancy of the medical art, was considered as a cause of disease, appears from an aphorism of Hippocrates: " Ubi in corpore sudor, ibi morbus."

"bus." The most natural inference we could draw from this sentence, would be his belief in the retention of the perspirable matter as injurious to the health of the body; for its presence in a part he considers a symptom of disease. The idea of morbific matter, as produced by a putrefactive fermentation in the blood, together with the fetid odour given out by sweat, in some diseases, led, probably, to the belief of its escape through this channel, as the most natural for its elimination from the system. To a suppression of perspiration then, were most disorders of the human body attributed. Morbific matter, by being retained, was carried back into the blood vessels, producing general affections, or by being confined to a part, gave origin to many local disorders. Hence proceeded erysipelas, herpes, and the several affections of the lungs and trahea.

Dr. Darwin, however, and several who have embraced his opinions, have rejected the notion of the suppression of this discharge having any share in the production or crisis of diseases. He has endeavoured to shew, from the practices among many nations of anointing with oil,* of the fashion of painting, and the use of powder and poinatum among ourselves, that perspiration

* Zoonom. part ii. pag. 24.

tion may be checked without injury. This may be, in a great measure, true; but the use of oil, and the other substances with which the body is sometimes smeared, does not entirely prevent the discharge of perspirable matter; for on increased exercise, the pores, tho' covered, are forced frequently by a copious flow of sweat. Were this not the case, the position would be in a greater degree established.

The operation of cold on the body, in producing disease, has been entirely attributed to the change produced in the living fibres,* and not to an obstruction of perspiration. This effect of cold will immediately be granted; but still the obstruction may have a considerable share in the operation. For by lessening the evacuation, a quantity of fluid will be retained, which quantity will be greater in proportion to the increase of exercise or temperature. This, therefore, will be an additional stimulus to those which are afterwards applied, and will consequently assist in throwing the system into violent action, which, by its force, will overcome the resistance of the cutaneous vessels, which, from their previous quiescence, and the present stimulus, must be excessively

* Med. Repos. Vol. ii. No. 1. Art. 13.

cessively excited; or by exciting fever, call for evacuations of a different kind. It is asserted, however, that the diminution of this is followed by the increase of another discharge. This will generally be admitted, but the increased evacuation is not always sufficient to counterbalance that which is checked; yet if it was, another part being obliged to make a greater exertion than that for which it was naturally destined, will necessarily be injured, and the greater and more permanent will that injury be, the greater the sensibility of the organ affected, and the longer the continuance of the cause which produced it. Thus, the intestines will suffer more than the kidneys, and the stomach more than the intestines. If the part affected be very important, the whole constitution will be proportionably deranged. As, for instance, such an affection will injure digestion, and hence, dyspepsia and the diseases consequent on an imperfection in this function. An affection of the intestines will give rise to colic, diarrhoea, cholera and dysentery. These diseases may frequently be referred to a determination to the bowels from suppressed perspiration.

With the effects of a suppressed perspiration, in producing catarrh, we are sufficiently acquainted. That it is checked during the inflammatory

flammatory symptoms of this affection, I think evident from what has been already said of it in the hot stage of fevers, and tho' the other parts of the body should be observed to perspire, the excessive action in the part affected, would prevent its appearance there.

The conclusion I shall therefore consider just, that the regular operations of this function cannot be arrested very suddenly, without creating some derangement. I shall now close the dissertation, without enlarging on what has been said, or attempting to explain the operation of those articles, the effects of which, as sudorifics, must be known to all.

————— *Si quid novisti recetius istis
Candidus imperti.* —————

HORAT.

And now, before I take leave of the subject entirely, I would wish the Professors to accept my sincere thanks for the instructions I have received from their lectures, and the many opportunities of improvement I have experienced thro' them, while a student in this University.

To Dr. Wistar I am particularly indebted, for the observations and instructions with which he has favoured me, both on this and numerous other subjects, and for several valuable cases in his private practice of surgery, with the inspec-

tion and knowledge of which he was kind enough to indulge me. For these, and his polite attention to me during my residence in this place, I beg he will accept my grateful acknowledgements, and be assured of my faithful remembrance.

F I N I S.



